GPS World
The Business and Technology of Global Navigation and Positioning

Geospatial solutions

GPS is Changing…A lot

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Agenda

Geospatial solutions
APPLYING THE POWER OF PLACE

1. Active/Planned GNSS
2. GPS/GLONASS/Galileo/BDS status
3. Public/Commercial SBAS status/changes
4. Public RTK base status
5. L5 signal deployment/benefits
6. GNSS technology trends

GNSS is the new GPS

GNSS = Global Navigation Satellite System

World-Wide GNSS

ACTIVE GNSS:

-GPS (USA)

-GLONASS (Russia)

-SBAS:

WAAS (North America), MSAS (Japan)

EGNOS (Europe)

Omnistar, Terrastar, Starfire (Worldwide)

-QZSS (Japan)

- BDS Regional (China)

PLANNED GNSS:

-Galileo (Europe)

-BDS Worldwide (China)

-SBAS: GAGAN (India)

-SBAS: SDCM (Russia)

-IGS RT (World-wide)

GNSS is Changing

- Not only is GNSS receiver technology constantly evolving, so is the GNSS infrastructure (satellites, signals and control).
- This is one of the reasons that the GNSS industry is so dynamic and will be for the foreseeable future.
- These changes will affect the way that GNSS mapping and surveying users perform their work.

GPS Constellation Status

- There are currently 31 operational GPS satellites.
- 20 x GPS Block IIA/IIR. L1 C/A, L1/L2 P(Y)
- 7 x GPS Block IIR-M. L1 C/A, L1/L2 P(Y), **L2C**
- 4 x GPS Block II-F. L1 C/A, L1/L2 P(Y), **L2C**, **L5**
- **L2C** = More robust iono correction for high precision positioning. No need for cross-correlation (semi-codeless).
- **L5** = Similar to L2C, but stronger signal @ 1176
  - Civil signals (black, red), Military signals (blue)

GLONASS
Russia's Satellite Navigation System

- Declared fully operational in December 2011.
- 24 operational satellites. Most since 1997.
- A valuable augmentation to GPS. Not used as a stand-alone system yet.
- Valuable to high-precision users (RTK, sub-meter) because it increases productivity.
- 5-10 satellites are added when using GLONASS.
- Increases productivity, not accuracy.

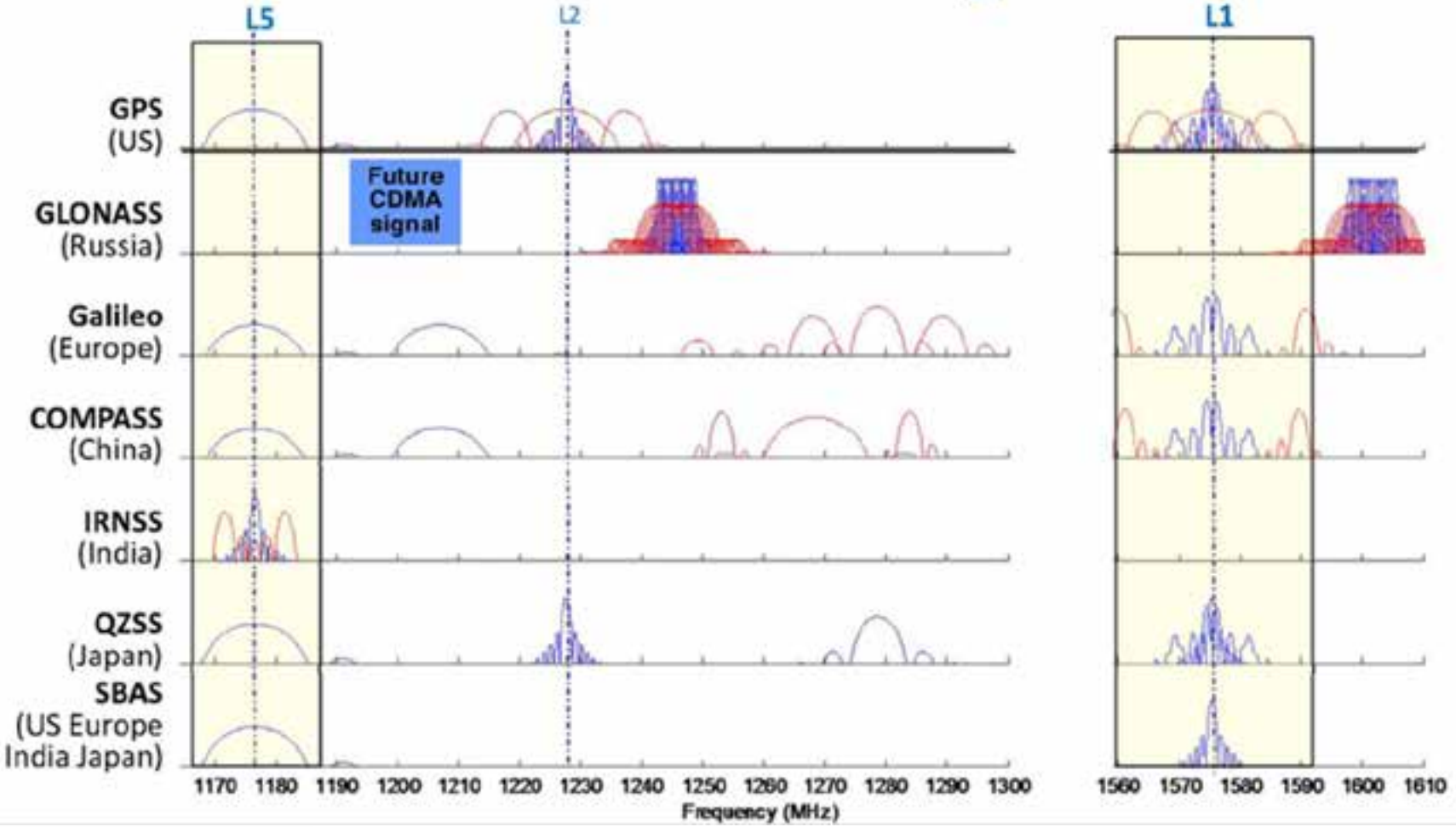
Galileo
Europe's Satellite Navigation System

- First launch of operational Galileo satellites (2) occurred in 2011. Two more Galileo satellites were launched Oct. 12, 2012.
- Production launches scheduled for Summer 2014. Launched in pairs.
- Constellation of 18 Galileo satellites projected for 2015/2016 timeframe.
- Highly compatible with GPS L1/L5.
- No L2 support.

BDS
China's Satellite Navigation System

- More high-precision GNSS receivers are sold in China than the rest of the world combined.
- BDS is currently a regional system of satellites orbiting in a figure eight pattern above China that add ~14 satellites on top of GPS and GLONASS.
- The RTK environment in China is better than any other place in the world due to the significant number of satellites in view.

Current International Signal Plans

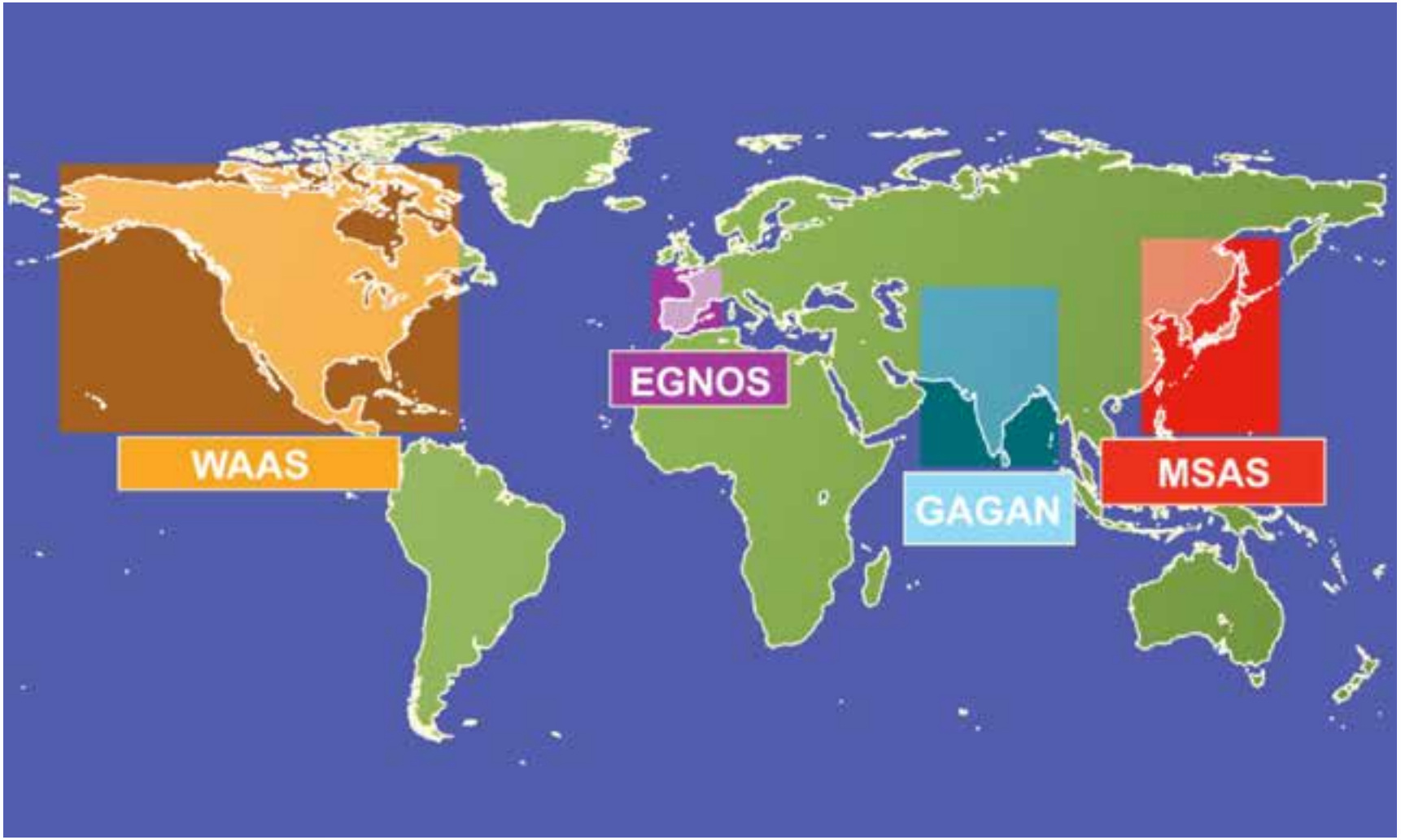


- GPS+Galileo = 20 average satellites in view.

	GPS	GALILEO	GPS+ GALILEO
Satellites	24+3	27+3	51+6
Avg # in View	8	12	20
RAIM Integrity	Fair	Fair	Excellent
Coverage	Good	Good	Excellent

- Add 30 more from BDS and 24 from GLONASS.

SBAS
Satellite-Based Augmentation System



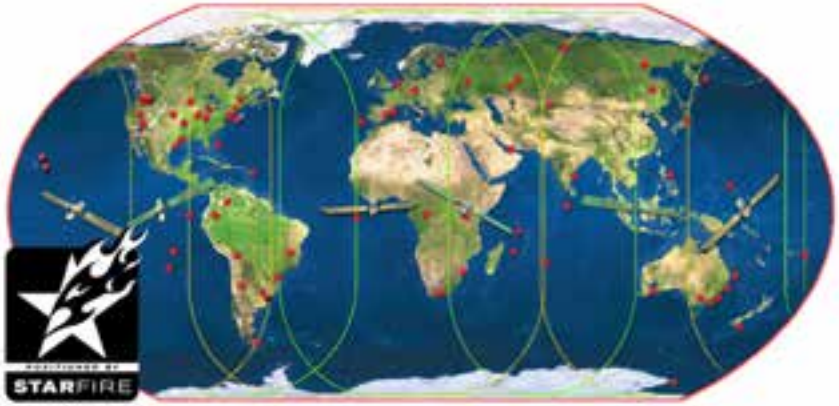
Public SBAS (sub-meter)

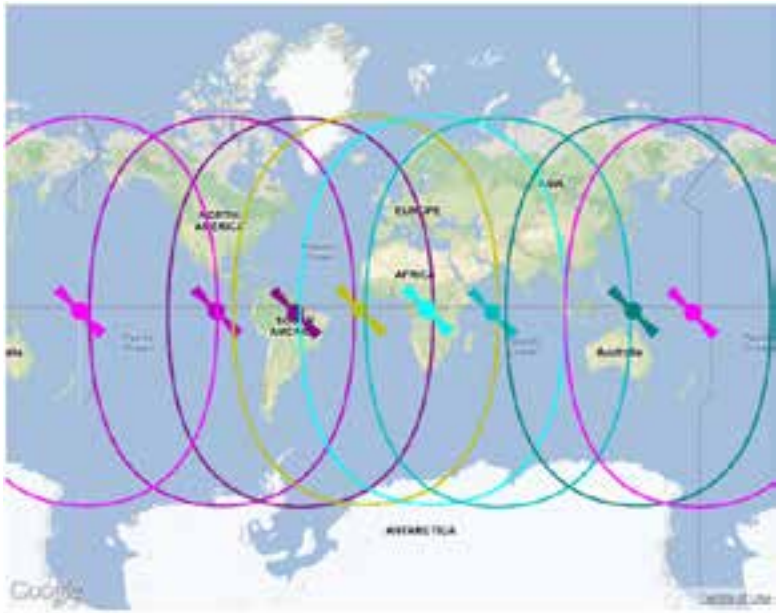
- SBAS – WAAS/EGNOS/MSAS/GAGAN. Free source of GPS L1 corrections.
- SBAS was designed for aviation, but used widely by geospatial professionals as an accurate source of GPS L1 corrections.
- SBAS was designed primarily for integrity, but can be optimized for accuracy to achieve sub-meter precision.

PPP SBAS (decimeter)

- Commercial PPP SBAS (decimeter world-wide subscription services):
  - Starfire
  - OmniSTAR
  - Terrastar
- Public PPP SBAS (free decimeter world-wide service):
- IGS RT <rt.igs.org>

OmniStar/Starfire/Terrastar





RTK

- Commercial RTK Networks
  - - Surveying equipment dealers
  - - GNSS eq. manufacturers – Trimble/Leica/Topcon
- Commercial RTK Clusters
  - - Agriculture
- Public RTK Networks
  - - State agencies (eg. Dept of Transportation)
- Public RTK Clusters
  - - Plate Boundary Observatory (PBO)

PBO RTK Bases

Public RTK Base Stations in the U.S.

Two recent examples of using Public RTK bases:

Public RTK Base Stations in the U.S.

Case #1. Colorado.

-Windows Mobile data collector w/AT&T SIM card for internet connectivity

-~12 mile baseline

-Accuracy: 1.9cm horizontal RMS. Adjusted from ITRF00 1997.0 to NAD83.2011 2010.0 using HTDP

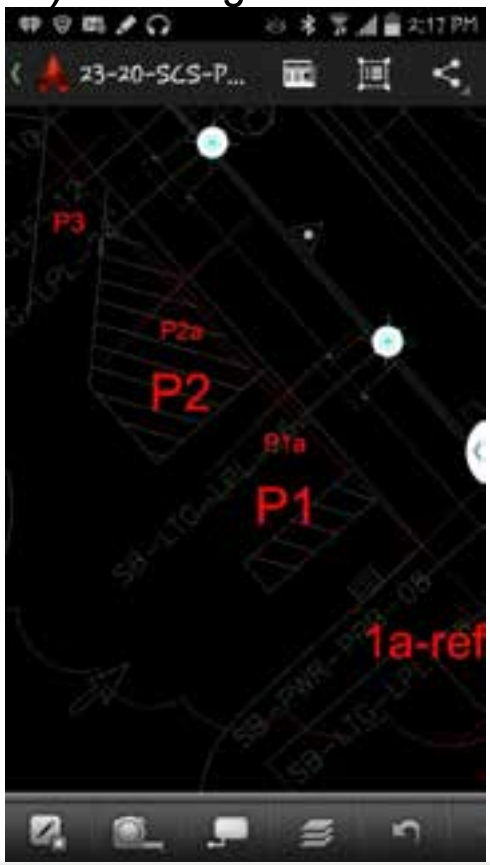
Public RTK Base Stations in the U.S.

Case #2. California (SF Bay Area)

-Samsung Note smartphone (Android) running AutoCAD 360.

-~5 mile baseline, 0.75” precision

- Accuracy: ????



Trend

Trending towards real-time decimeter (PPP) and centimeter positioning (RTK)

Never in history has real-time, high-precision technology been so available and affordable.

And we're only just beginning.....

High-Precision GNSS Technology

The Next 5 Years

The Next 5 Years

- Complete hybrid L5 constellation (GPS/Galileo/BDS).
- Cheaper/more accurate GNSS receivers.
- Initial deployment of Europe's Galileo and Chinese BDS.
- Continued proliferation of RTK base stations.
- Further refinement of PPP real-time services (eg. Trimble RTX, IGS-RT).

Takeaways

- The new GPS L5 signal will result in very low-cost L1/L5 receivers capable of cm-level horizontal/vertical precision.
- High-precision GPS receivers trending towards commoditization.
- RTK on your mobile phone by 2020?

Comments?

Questions?

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